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Imperfect competition, expectations and the multiple effects of monetary growth

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Imperfect Competition,
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by
Neil Rankin

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IMPERFECT COMPETITION, EXPECTATIONS AND THE MULTIPLE EFFECTS OF MONETARY GROWTH*

Neil Rankin

We show that imperfect competition intensifies the problem of how to model expectations in macroeconomics. If agents are assumed to forecast in a 'backward-looking' manner, then, despite confining attention to forecasting rules which ensure no errors in the steady state, there is a continuum of steady states with different properties, each associated with a different forecasting rule. By contrast, under perfect competition, or in 'ad hoc', non-optimising macromodels, any forecasting method which ultimately eliminates mistakes results in a unique steady state, with unique properties. If, on the other hand, agents are assumed to forecast in a 'forward-looking' manner, i.e. to have perfect foresight, then the steady state will be unique. However, such an expectations assumption not only requires agents to have much greater knowledge about the working of the economy than in perfectly competitive economies, but the information needed concerns out-of-equilibrium behaviour, which by definition is never actually observed.

The dependence of the steady state on the forecasting rule results from the fact that the rule is one factor which determines the elasticity of demand faced by imperfectly competitive agents. Since elasticities are central to the conditions which determine an imperfectly competitive equilibrium, the forecasting rule has an influence on the equilibrium, which remains present even when the economy is in a steady state with validated expectations. The lack of such an influence under perfect competition is because the elasticity of demand facing agents is then exogenous: by assumption, infinity. Another way to view forecasting-rule dependence is to note that although backward-looking rules may imply correct forecasts everywhere along the equilibrium time path of an economy,¹ with respect to behaviour off the equilibrium time path they imply errors, and different rules imply different errors. This distinction does not arise under perfect competition, since a deviation by one agent from her equilibrium

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¹ The existence of a class of rules which implies no errors in the short as well as in the long run will be shown.

strategy there has no effect on future (or current) prices, and so requires no change in other agents' forecasts.

The organisation of the paper is as follows. Section I describes the structure of the model, which is a monetary overlapping-generations model with imperfect competition in the labour market, inspired by the seminal work of Hart (1982). The contrasting effects of changes in monetary growth on steady-state output under different forecasting rules are studied in Section II, and an illustration using a CES parameterisation is provided in Section III. Section IV considers the robustness of forecasting-rule dependence.

I. THE STRUCTURE OF THE MODEL

In outline, the economy contains two homogeneous commodities – goods and labour – and a single asset – non-interest-bearing money, whose supply is exogenously determined by the government. There are three types of private-sector agent: firms, households and trade unions. Firms are price- and wage-takers who produce goods using labour as the sole input. Households are composed of overlapping generations with two-period lives, and form a constant population. Each household works only when young and is exogenously assigned to a trade union. The union's objective, as in Hart (1982), is to maximise the money wage revenue of its members. This is consistent with maximising members' utilities since no utility of leisure is assumed, something which also implies that the underlying competitive labour supply just equals the sum of households' exogenous time endowments. Imperfect competition takes the form of a Cournot quantity-setting oligopoly between unions.²

Imperfect competition is what gives the model interest as a theory of output and employment determination, since with a Walrasian labour market employment would equal the competitive labour supply and so be exogenous. With a unionised labour market, the equilibrium involves unemployment for some subset of the parameter space, creating scope in principle for monetary policy to affect output.

Optimisation Problems of Individual Agents

In each local labour market³ there are n identical unions. The problem which union i faces is:

$$\text{maximise } WL_i \text{ subject to } L_i + L' = g(W; \dots) \text{ and } L_i \leq \bar{L}, \quad (1)$$

L_i is the quantity of labour sold by union i , and \bar{L} is its labour endowment. L' is the labour sales of the other $n-1$ unions, which are taken as given by union i under the Cournot assumption. $g(W; \dots)$ is the market labour demand function,

² The model differs from Hart's (a) by dispensing with oligopoly in the goods market, which is inessential for present purposes, (b) by explicitly including money rather than a 'non-produced good', and (c) by being dynamic rather than static. A static version, which looks at the neutrality, as opposed to the superneutrality, of money, is constructed in Rankin (1992). For surveys of the general literature on the macroeconomics of imperfect competition to which these papers relate, see Silvestre (1991) and Dixon and Rankin (1991).

³ Like Hart, we divide the economy into a large number of separate but identical locations. To avoid notational clutter, these are not formally indexed. Each firm is tied to a location where it draws labour from the local labour market and sells it in the local goods market. Each household is allocated to one location as a worker, to a different one as a consumer, and to yet a third as a shareholder. This ensures that a union is justified in taking its members' consumption prices and profit receipts as given; and in taking the incomes of its firms' customers as given.

whose exact form will be determined below. From the first-order condition for solving (1), assuming an equilibrium which is symmetric across the n unions so that $L_t = L/n$ ($L \equiv L_t + L'$), we obtain the central relationship:

$$1/n \leq -\epsilon(W; \dots), \quad 1/n \leq \bar{L}, \quad \text{with complementary slack,} \quad (2)$$

where

$$\epsilon(W; \dots) \equiv [\partial g(\cdot) / \partial W] [W/L], \quad (3)$$

ϵ is the money-wage elasticity of the market labour demand function $g(\cdot)$, and so in general a function of the same variables. Our interest centres on the case where $L/n < \bar{L}$, i.e. on equilibrium with unemployment, in which case the first part of (2) holds as a strict equality.⁴

Firms are perfect competitors in all markets. The representative firm has a concave production function $y = f(L)$ and so maximises profits where $W/p = f'(L)$. Inverting this yields the decreasing labour demand function $L = L^d(w)$, where $w \equiv W/p$. For future reference, define the real-wage elasticity of labour demand as $\epsilon_L \equiv [dL^d(w)/dw] [w/L]$, and note that in general it can be regarded as a function of any one of (w, L, y) . The form of the function clearly depends purely on the form of the production function $f(L)$. We similarly define the output supply function $y = y^*(w)$ ($\equiv f(L^d(w))$) and the real-wage elasticity of output supply, $\epsilon_s \equiv [dy^*(w)/dw] [w/y]$.

The third type of agent is the consumer, whose lifetime optimisation problem is:

$$\text{maximise } u(c_t^Y, c_{t+1}^O) \quad \text{subject to} \quad Y_t + S_t^Y = p_t c_t^Y + M_t, \quad M_t + S_{t+1}^O = p_{t+1} c_{t+1}^O.$$

Superscripts Y, O denote respectively the young and old generation in any period. c_t indicates consumption, M_t nominal money balances held at the end of period t , Y_t nominal income from wages and profits. Y_t is also national income (per location), since only the young earn wages and for convenience we assume they also receive all profits. S_t^Y, S_t^O are lump-sum subsidies, by means of which the government increases or decreases the money supply. We assume preferences to be homothetic, so that the resulting demand functions have the forms (the implicit non-negativity constraint on M_t is taken never to bind):

$$c_t^Y = \alpha(p_{t+1}/p_t) [Y_t + S_t^Y + S_{t+1}^O]/p_t, \quad c_t^O = [M_{t-1} + S_t^O]/p_t, \quad (4)$$

$\alpha(p_{t+1}/p_t)$ is a function which is decreasing if current and future consumption are gross substitutes in consumers' preferences, increasing if they are gross complements. Note that the expression for c_t^O is just a rearrangement of the budget constraint.

Total goods demand at a location in period t is simply the sum of the two demands in (4). An important variable is the price elasticity of total goods demand, which we denote ϵ_D . ϵ_D is a weighted average of the elasticities of the two components of demand, the weights being their shares in total consumption. For the old's demand, the elasticity is clearly just -1 . For the young's demand, the calculation of the elasticity must take into account the

⁴ Concavity of wage revenue in the wage, i.e. satisfaction of the second-order conditions for (2) to define a maximum, cannot in general be taken for granted. A set of sufficient conditions for concavity is presented in a longer version of the paper, Rankin (1991).

fact that, under backward-looking expectations, a change in p_t may affect the consumer's forecast of p_{t+1} , which thus provides a further mechanism for a change in demand. Denote the forecasting rule very generally as $p_{t+1}^e = \Psi(\Omega_t)$, where Ω_t is the set of current and past variables on which the consumer bases her forecast. If Ω_t includes the current price p_t , $\Psi(\cdot)$ will imply some elasticity of expectations γ , where $\gamma \equiv [\partial p_{t+1}^e / \partial p_t] [p_t / p_{t+1}^e]$. Differentiating the young's demand with respect to p_t , and using this in the weighted-average expression for total demand elasticity, we then obtain:

$$\epsilon_D = -1 - [c_t^Y / y_t] [1 - \gamma] [p_{t+1}^e / p_t] \alpha' (p_{t+1}^e / p_t) / \alpha (p_{t+1}^e / p_t). \quad (5)$$

The presence of γ in this expression is the key to the dependence of the equilibrium on the forecasting rule, as will be seen. Under the alternative assumption of perfect foresight, p_{t+1} is treated as if directly observable by consumers, and so no subjective link is made to p_t . The elasticity in this case is found by setting $\gamma = 0$ (and $p_{t+1}^e = p_{t+1}$) in (5).

Alternative Expectations Hypotheses

A backward-looking forecasting rule may be the outcome of a relatively sophisticated learning process, such as an OLS regression, or simply a plausible but *ad hoc* rule of thumb. For example, the class of autoregressive rules in the inflation rate may be represented as:

$$\ln (p_{t+1}^e / p_t) = \sum_{i=0}^{\infty} \lambda_i \ln (p_{t-i} / p_{t-i-1}). \quad (6)$$

The condition for this to yield a correct forecast in a constant-inflation steady state is $\sum_{i=0}^{\infty} \lambda_i = 1$. Consistently with this, the implied elasticity of expectations, γ , can take any value, since it is given by $\partial \ln p_{t+1}^e / \partial \ln p_t = 1 + \lambda_0$, and λ_0 may be chosen arbitrarily.⁵

Autoregressive rules, however, exclude other variables which may be relevant to predicting inflation, such as the money supply. A simple forecasting rule which uses this is 'monetarist' expectations:

$$p_{t+1}^e / p_t = M_t / M_{t-1}. \quad (7)$$

Since inflation must equal the monetary growth rate in a steady state, this too ensures a correct long-run forecast. In fact below we will see that it yields correct forecasts in all time periods, for the particular type of policy which we consider. From (7) it is immediate that monetarist expectations imply $\gamma = 1$.

To implement the alternative hypothesis of forward-looking expectations, we simply assume, as already indicated, that consumers have perfect foresight concerning p_{t+1} . Whereas our backward-looking forecasting behaviour satisfies only a weak criterion of 'rationality' – that forecasting errors should be eliminated in the long run – forward-looking forecasting behaviour satisfies a rationality criterion which is stronger on two counts. First, it guarantees no forecasting errors in the short and medium runs, as well as in the long run. However, as noted, some backward-looking rules such as monetarist

⁵ The most familiar version of (6) is 'adaptive' expectations where $\ln (p_{t+1}^e / p_t) - \ln (p_t^e / p_{t-1}) = \lambda [\ln (p_t / p_{t-1}) - \ln (p_t^e / p_{t-1})]$, $0 < \lambda < 1$, so we have $\gamma = 1 + \lambda > 1$.

expectations are capable of ensuring this too, and indeed we shall see that a whole class of rules can be constructed which ensure it, and yet each implies a different steady state. The reason this is possible is that such rules still imply forecast errors with respect to actions by imperfectly competitive agents which take the economy off an equilibrium time path. That is, the effect on p_{t+1} of a unilateral deviation by union i from its utility-maximising choice of L_u is incorrectly forecast by such rules. The forward-looking expectations hypothesis imposes correct forecasts with respect to such deviations, and thus satisfies a stronger criterion of rationality. It, of course, does not follow from this that it is necessarily a better description of actual forecasting behaviour. It requires much more knowledge about the structure of the economy than is required for forward-looking expectations in competitive economies, where a deviation by an agent from his utility-maximising choice has a negligible effect on prices and so requires no adjustment to forecasts by other agents. Moreover, since by definition the economy is always on its equilibrium time path, it is hard to see how agents could ever observe mistakes in their forecasts with respect to out-of-equilibrium behaviour, and so learn to form true forward-looking expectations.

Definition of Equilibrium

The clearing condition for equilibrium in a local goods market may now be written as:

$$y^*(W_t/p_t) = \alpha(p_{t+1}^e/p_t) [Y_t + S_t^Y + S_{t+1}^{O,e}]/p_t + [M_{t-1} + S_t^O]/p_t. \quad (8)$$

Taking into account that under backward-looking expectations $p_{t+1}^e = \Psi(\Omega_t)$ where in general Ω_t contains p_t , this makes the local goods price p_t an implicit function of several variables: the local money wage W_t , the money income of local consumers Y_t , their initial money balances M_{t-1} , current and expected future subsidies, and any further variables in Ω_t apart from p_t itself (call them Ω_t^-). This function we summarise as $p(W_t, \dots)$. Using it to substitute out p_t from the labour demand function of local firms, we obtain:

$$L = L^d(W_t/p(W_t, \dots)) \equiv g(W_t; Y_t, M_{t-1}, S_t^Y, S_t^O, S_{t+1}^{O,e}, \Omega_t^-). \quad (9)$$

This reveals what underlies the market labour demand function first introduced in (1). It differs from the labour demand function of a firm because it endogenises the price level: unions know that by restricting employment and pushing up the local wage, they will also push up the local price, and take this into account. Therefore its form depends on three factors: firms' technology $f(\cdot)$, consumers' preferences $u(\cdot)$, and – most importantly for our purposes – consumers' forecasting rule $\Psi(\cdot)$.

Under forward-looking expectations the forecasting rule $\Psi(\cdot)$ is replaced by the condition $p_{t+1}^e = p_{t+1}$. p_{t+1} thus becomes an argument of $g(\cdot)$, in place of Ω_t^- . When labour demand elasticity ϵ is calculated by taking the partial log-derivative of $g(\cdot)$ with respect to W_t , it is thus implicitly assumed that the true p_{t+1} faced by local consumers is unaffected when local unions push up W_t and thus p_t . For this to be valid, we need to add the rider that consumers at the location are dispersed amongst new locations in the second period of life, so that

any influence of a change in p_t on the money stock which a consumer decides to carry over does not significantly affect the total demand, and therefore the price, in his new location.⁶

Having elucidated the relationships underlying $g(\cdot)$, by differentiating (8) and (9) we may obtain an expression for ϵ in terms of its constituent elasticities:

$$\epsilon = \epsilon_L \epsilon_D / [\epsilon_S + \epsilon_D], \quad (10)$$

where ϵ_L , ϵ_S , ϵ_D were defined above. Using this in the labour market equilibrium condition (2) (focusing on the equilibrium with unemployment) gives:

$$1/n = -\epsilon_L \epsilon_D / [\epsilon_S + \epsilon_D]. \quad (11)$$

Or:
$$-\epsilon_D = \epsilon_S(y_t) / [1 + n\epsilon_L(y_t)] \equiv z(y_t), \quad \text{say.} \quad (12)$$

We noted earlier that ϵ_L , ϵ_S may be viewed as functions of y_t , so that the right hand side of (12) is a function of y_t whose form depends purely on the form of the production function $f(\cdot)$. Substituting out $-\epsilon_D$ by (5), we have:

$$1 + [c_t^Y/y_t] [1 - \gamma] [p_{t+1}^e/p_t] \alpha'(p_{t+1}^e/p_t) / \alpha(p_{t+1}^e/p_t) = z(y_t). \quad (13)$$

To close the model, we impose symmetry across locations. This means that the value of output at a location, $p_t y_t$, must equal the money income of consumers who spend there, Y_t . Using this in the consumption demand functions (4), we obtain the following expressions for aggregate demand and the consumption share of the young generation:

$$y_t = \alpha(p_{t+1}^e/p_t) [y_t + [S_t^Y + S_{t+1}^{O,e}]/p_t] + [M_{t-1} + S_t^O]/p_t, \quad (14)$$

$$c_t^Y/y_t = \alpha(p_{t+1}^e/p_t) [1 + [S_t^Y + S_{t+1}^{O,e}]/p_t y_t]. \quad (15)$$

Under backward-looking expectations, (13)–(15) together with the forecasting rule $p_{t+1}^e = \Psi(\Omega_t)$ (and a similar rule for $S_{t+1}^{O,e}$) determine $(p_t, y_t, c_t^Y/y_t)$. Under forward-looking expectations, these variables are determined by (13)–(15) together with $p_{t+1}^e = p_{t+1}$, $S_{t+1}^{O,e} = S_{t+1}^O$, and $\gamma = 0$. In the first case, the period- t equilibrium is in general contingent on lagged variables, as components of Ω_t , so to trace out the complete time path requires the solution of a system of backward-looking difference equations. In the second case it is contingent on the future variable p_{t+1} , so the time path is described by a forward-looking difference equation system, for which the standard solution is to employ a 'saddlepath' criterion.⁷

II. STEADY-STATE BEHAVIOUR

In this section we solve for the steady state and show how the effect on it of changes in the rate of growth of the money supply are sensitive to the forecasting rule. Assume that the government chooses a constant rate of

⁶ The alternative assumption in which forward causation from p_t to p_{t+1} is allowed would enrich the analysis under forward-looking expectations, but this would be a distraction from the main point which we seek to make in the paper.

⁷ A longer version of the paper (Rankin, 1991) contains an analysis of the local stability of the steady state under different expectations assumptions. Ensuring the appropriate degree of stability poses no unusual problems. The analysis is omitted here since it is unrevealing for the steady state comparative statics.

monetary growth, θ (which could be negative). Monetary expansion (contraction) occurs through the lump-sum subsidies (taxes). If fraction ϕ of the total subsidy goes to the old generation, then subsidies are given by

$$S_t^Y = [1 - \phi] \theta M_{t-1}, \quad S_t^O = \phi \theta M_{t-1}, \quad S_t^Y + S_t^O = M_t - M_{t-1} = \theta M_{t-1}. \quad (16)$$

A steady state must involve constant values over time of all real variables. To keep real money balances constant the inflation rate must thus equal θ , and since expectations are by construction always validated in a steady state, the expected inflation rate equals θ too. Using this fact and substituting (16) into (13)–(15),⁸ we derive the following steady-state version of (13):

$$1 + [1 - \gamma] [1 + \theta]^2 \alpha' (1 + \theta) / [1 + \theta \alpha (1 + \theta)] = (-\epsilon_D) = z(y). \quad (17)$$

Equation (17) determines the steady state output level, y , as an implicit function of the monetary growth rate, θ . It is valid for both backward- and forward-looking expectations, with only the restriction that $\gamma = 0$ under the latter.

The effect of an increase in θ on y clearly depends, first, on whether the left hand side of (17), which is the steady state value of the price elasticity of demand $-\epsilon_D$, is increasing or decreasing in θ ; and, second, on whether the $z(y)$ function on the right hand side of (17) is increasing or decreasing in y . It is in fact most likely that the $z(y)$ function is increasing, as the CES example in the next section illustrates. Whether $-\epsilon_D$ is increasing or decreasing depends on whether $[1 + \theta]^2 \alpha' / [1 + \theta \alpha]$ is increasing or decreasing in θ , and on the sign of $1 - \gamma$. From this last we directly see the dependence of the steady state on the forecasting rule. Since different forecasting rules imply different values of the elasticity of expectations γ , as pointed out in the previous section, it follows that they also imply different effects of an increase in θ on long-run output. For example, under 'monetarist' expectations $\gamma = 1$, whence $-\epsilon_D = 1$, and monetary growth has no effect on output (money is 'superneutral'). Under 'adaptive' expectations $\gamma > 1$, so that whatever the sign of $dy/d\theta$, it is opposite to the sign under forward-looking expectations, for which $\gamma = 0$. In general, any two backward-looking forecasting rules which embody different values for the elasticity of expectations γ will imply different effects of monetary growth on steady-state output.

It must be stressed that these differences do not result from different forecast errors made under different forecasting rules, since such errors are absent by assumption in the steady state. Nor do they result from different forecast errors made in the short run along the transition path to the steady state. We can illustrate this by showing that under 'monetarist' expectations, forecasts are correct in the short as well as in the long run, and yet we have just seen that the long-run behaviour of the economy is different from that under forward-looking expectations where there are also no short-run errors. Since $\gamma = 1$ under monetarist expectations, (13) shows that output is determined exogenously by $1 = z(y_t)$ in every period, not just in the long run. Using this

⁸ S_{t-1}^O is assumed to be forecast as $[1 + \theta] S_t^O$, which is always a correct forecast except just prior to an unanticipated change in θ .

output level (y_n , say) in the aggregate demand equation (14), together with (16) and the monetarist rule $p_{t+1}/p_t = 1 + \theta$ itself, we obtain the equation:

$$y_n = [1 - \alpha(1 + \theta)]^{-1} [1 + \phi\theta] [1 + \theta\alpha(1 + \theta)] M_{t-1}/p_t. \quad (18)$$

This shows that real balances must be constant for all t , and thus that p_t must grow at the same rate as M_{t-1} in all periods, i.e. at θ , exactly as the monetarist forecasting rule predicts. Note that under this simple rule the economy reaches its steady state immediately.^{9,10}

The fundamental reason for the multiplicity of steady states generated by different forecasting rules is that different rules imply different mistakes by households in forecasting the effects of deviations by unions from their utility-maximising strategies. Under our assumption that consumers are reshuffled between locations in the second period of life, a union which pushes up the local price p_t has no effect on the true p_{t+1} which local consumers face, yet backward-looking consumers will respond by raising their expected prices by an amount which depends on γ . This changes their current demand for the good in a way which is taken into account by unions, who know the true labour demand curve which they face. Because consumers' errors are errors in forecasting hypothetical, not necessarily actual, behaviour, there is no reason why consumers who, through a process of learning or trial-and-error, have arrived at a successful forecasting method, should have any incentive to change it. The powerful 'rational expectations' argument that forecasting rules which imply indefinitely repeated errors will be rejected no longer suffices to tie down long run behaviour.

III. A CES EXAMPLE

We now provide a concrete illustration of the steady-state comparative statics. If the production function is CES over labour and capital, where capital is a fixed parameter, then we may derive an explicit form for the function $z(y)$.¹¹ To ensure an unemployment equilibrium exists in the 'benchmark' case where $\gamma = -\epsilon_D = 1$, i.e. that (12) can be satisfied, we need the elasticity of substitution σ to be less than $1/n$, which yields a $z(y)$ function with the shape shown in Fig. 1. Noting (12), a positive slope of $z(y)$ implies that an increase in output is caused by anything which increases the elasticity of goods demand. This is what we would expect intuitively: a rise in $-\epsilon_D$ lowers unions' monopoly power and so weakens their monopolistic restriction of employment and output.

⁹ The point in this paragraph may be further emphasised by noting that a complete class of forecasting rules which yield no short-run errors can be constructed, one for each value of γ . Consider:

$$p_{t+1}/p_t = k_\theta [1 + \theta] [p_t/M_{t-1}]^{\gamma-1}.$$

In a steady state with y given by (17) this will forecast correctly provided k_θ is chosen such that $k_\theta = m^{\gamma-1}$, where m is steady-state real balances (and therefore dependent on θ). It is straightforward to obtain an equation similar to (18) and so show again that p_t must grow at the same rate as M_{t-1} in every period t , whence the system is always in the steady state and so yields correct forecasts in every t .

¹⁰ The success of the monetarist forecasting rule (and of the rules in the preceding footnote) is of course contingent on the policy regime, as with any backward-looking rule. It would break down if, for example, the government chose a dynamic time path for θ rather than fixed it permanently.

¹¹ The function used is: $y = A[\beta k^{(\sigma-1)/\sigma} + (1-\beta)L^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)}$, where $\sigma > 0$, $0 < \beta, n < 1$. A fuller exposition of its implications for $z(y)$ is given in Rankin (1992).

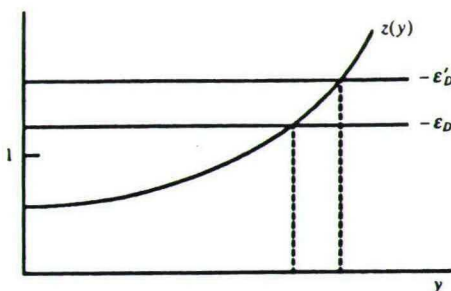
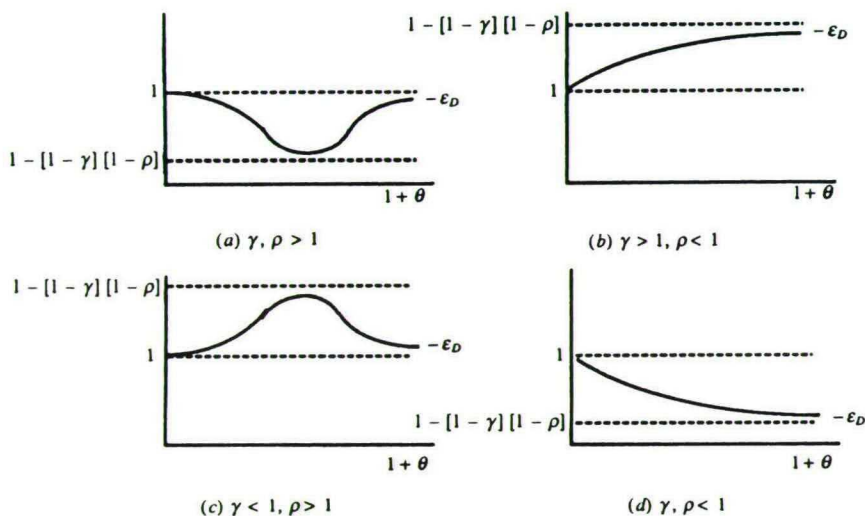
Fig. 1. The $z(y)$ function.

Fig. 2. The effect of monetary growth on demand elasticity.

The effect of θ on the steady-state elasticity of goods demand, $-\epsilon_D$, depends on the sign of $\gamma - 1$ and on whether the term $[1 + \theta]^2 \alpha' / [1 + \theta \alpha]$ is increasing or decreasing in θ (see (17)). To examine the latter we use the CES utility function, with an elasticity of intertemporal substitution in consumption of ρ .¹² From this we may derive:

$$-\epsilon_D = 1 - [1 - \gamma][1 - \rho] / \{ [1 + \delta^\rho [1 + \theta]^{1-\rho}] [1 + \delta^{-\rho} [1 + \theta]^{\rho-1}] \}. \quad (19)$$

The function (19) is sketched in Fig. 2. There are four cases, depending on the signs of $\gamma - 1$ and $\rho - 1$. As already seen, changing the sign of $\gamma - 1$ reverses the effect of θ on $-\epsilon_D$ and hence on y . This is visible in that panels (c) and (d) are the mirror images of (a) and (b). Fig. 2 also shows that the sign of $\rho - 1$ is important. Under gross substitutability between current and future consumption ($\rho > 1$), an increase in θ has the opposite effect on $-\epsilon_D$ (for values

¹² The CES utility function is: $u = \{ [c^Y]^{1-\rho-1/\rho} + \delta [c^O]^{1-\rho-1/\rho} \}^{\rho/(1-\rho-1)}$, where $\rho > 0$, $0 < \delta < 1$.

of θ in the lower range) to its effect under gross complementarity ($\rho < 1$). Two effects are at work in causing these changes. First, just as in the competitive pure exchange model, higher θ increases the young generation's share in total consumption. This weights total demand elasticity towards that of the young, and since the latter is greater (in absolute terms) than that of the old as $[\gamma - 1][\rho - 1] < 0$ or > 0 respectively, this raises $-\epsilon_D$ in cases (b) and (c), lowers it in (a) and (d). Second, higher θ affects the young's demand elasticity itself, positively if $\gamma > 1$, negatively if < 1 . Since the sign of the effect does not depend on the sign of $\rho - 1$, it reinforces the first effect in cases (b) and (d) but counteracts it in (a) and (c), causing the trough and hill shapes in the latter.¹³

IV. ROBUSTNESS OF THE RESULTS

Our broad conclusion, already stated in the introduction, is the negative one that imperfect competition exacerbates the problem of modelling expectations in macroeconomics. In the present model, it is impossible to predict the long-run effect of higher monetary growth on output unless either we make the extremely informationally-demanding assumption of forward-looking expectations, or we select one out of an infinity of perfectly accurate backward-looking forecasting rules as being more likely. Imperfect competition means that we must pay more attention to the issue of how agents forecast, since it is important for the long run and not just the short run, as in competitive economies.

Not all dynamic models of imperfectly competitive economies necessarily exhibit this forecasting-rule dependence: several features are necessary for it to occur. However it is a general property of imperfectly competitive models insofar as many other models can be envisaged which will generate it, and unless care is taken deliberately to exclude the features which give rise to it, such a phenomenon is likely to be encountered from time to time in future research on the macroeconomics of imperfect competition. A first requirement, which should already be clear from the foregoing, is that unions must be able to influence goods prices. Without this the elasticity of goods demand is irrelevant for the elasticity of labour demand faced by unions, and thus so are consumers' forecasting rules. For example the framework used by Blanchard and Kiyotaki (1987) does not satisfy this, since each firm employs a very small amount of the labour of each union, so that the elasticity of demand faced by the latter is determined solely by the firm's technology.

A second necessary feature is an intertemporal substitution effect. In the present model, this operates through consumption. It is easy to see that if consumption is unaffected by a change in the intertemporal relative goods price of goods (i.e. by the real interest rate), then forecasting-rule dependence disappears: this is the case $\alpha' = 0$ in (13). While the sign and magnitude of the

¹³ A corollary of these effects of θ on y is that the optimal rate of monetary growth differs from that in a competitive economy. In the latter (assuming no discounting of future generations' utilities in the social welfare function) the optimum growth rate is zero, since this minimises the distributional distortions. Here the distributional distortions must be weighed against beneficial output effects of non-zero inflation. In case (c), for example, the optimum will lie at some θ between zero and the output-maximising value.

intertemporal substitution effect on consumption are still a matter of empirical controversy, the introduction of investment to the model would provide a second, and more powerful, channel for such an effect to operate.

A final requirement (though this would not apply if the effect were through investment) is that the consumer should spend a non-negligible fraction of her income on the good in imperfectly competitive supply. In our model the consumer buys only one type of good, from a single source of supply (firms at the consumer's location, whose common price is under the influence of the local unions). We could relax this somewhat, but not as far as the 'monopolistic competition' framework popular in much of the literature, in which each consumer buys a large number of goods, such that the price of a single good has a negligible effect on the *index* of prices relevant for the consumer. With the CES utility function used in this literature, demand for good i depends on its own price and on the index of all prices. A rise in the current price of a single good, i , although it may cause the consumer to forecast a rise in the future price of good i , and maybe in the future prices of other goods j , will still under any likely forecasting rule have a negligible effect on the price *index*, so that the forecasting rule will be irrelevant to the consumer's elasticity of demand.

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